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3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

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   DY8 3PQ

   Patents ADP number *(if you know it)* — 6463632001

   If the applicant is a corporate body, give the country/state of its incorporation — United Kingdom

4. Title of the invention — NOZZLE ARRANGEMENTS

5. Name of your agent *(if you have one)*

   "Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

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   Patents ADP number *(if you know it)* — 7710734001

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

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Number of earlier application	Date of filing *(day / month / year)*

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Date 4 July 2003

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Dr A Wells
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NOZZLE ARRANGEMENTS

The present invention relates to nozzle arrangements. More particularly, but not exclusively, the present invention relates to nozzle arrangements that are adapted to generate a spray of a fluid, which is forced to flow through the nozzle arrangement under pressure.

Nozzles are often used to provide a means of generating sprays of various fluids. In particular, nozzles are commonly fitted to the outlet valves of pressurised fluid-filled containers, such as so-called "aerosol canisters", to provide a means by the fluid stored in the container can be dispensed in the form of a spray or mist. A large number of commercial products are presented to consumers in this form, including, for example, antiperspirant sprays, deodorant sprays, perfumes, air fresheners, antiseptics, paints, insecticides, polish, hair care products, pharmaceuticals, water and lubricants. In addition, pump or trigger-actuated nozzle arrangements, i.e. arrangements where the release of fluid from a non-pressurised container is actuated by the operation of a manually operable pump or trigger that forms an integral part of the arrangement, are also frequently used to generate a spray or mist of certain fluid products. Examples of products that typically incorporate pump or trigger nozzle devices include various lotions, insecticides, as well as various garden and household sprays.

A spray is generated when a fluid is caused to flow through a nozzle arrangement under pressure. To achieve this effect, the nozzle arrangement is configured to cause the fluid stream passing through the nozzle to break up or "atomise" into numerous droplets, which are then ejected through an outlet of the arrangement in the form of a spray or mist.

The optimum size of the droplets required in a particular spray depends primarily on the particular product concerned and the application for which it is

intended. For example, a pharmaceutical spray that contains a drug intended to be inhaled by a patient (e.g. an asthmatic patient) usually requires very small droplets, which can penetrate deep into the lungs. In contrast, a polish spray preferably comprises spray droplets with larger diameters to promote the impaction of the aerosol droplets on the surface that is to be polished and, particularly if the spray is toxic, to reduce the extent of inhalation.

The size of the aerosol droplets produced by such conventional nozzle arrangements is dictated by a number of factors, including the dimensions of the outlet orifice and the pressure with which the fluid is forced through the nozzle. However, problems can arise if it is desired to produce a spray that comprises small droplets with narrow droplet size distributions, particularly at low pressures. The use of low pressures for generating sprays is becoming increasingly desirable because it enables low pressure nozzle devices, such as the manually-operable pump or trigger sprays, to be used instead of more expensive pressurised containers and, in the case of the pressurised fluid-filled containers, it enables the quantity of propellant present in the spray to be reduced, or alternative propellants which typically produce lower pressures (e.g. compressed gas) to be used. The desire to reduce the level of propellant used in aerosol canisters is a topical issue at the moment and is likely to become more important in the future due to legislation planned in certain countries, which proposes to impose restrictions on the amount of propellant that can be used in hand-held aerosol canisters. The reduction in the level of propellant causes a reduction in the pressure available to drive the fluid through the nozzle arrangement and also results in less propellant being present in the mixture to assist with the droplet break up. Therefore, there is a requirement for a nozzle arrangement that is capable of producing an aerosol spray composed of suitably small droplets at low pressures.

A further problem with known pressurised aerosol canisters fitted with conventional nozzle arrangements is that the size of the aerosol droplets generated tends to increase during the lifetime of the aerosol canister, particularly towards the end of the canisters life as the pressure within the canister reduces as the propellant becomes gradually depleted. This reduction in pressure causes an observable increase in the size of the aerosol droplets generated and thus, the quality of the spray produced is compromised.

Accordingly, it is an object of the present invention to provide a nozzle arrangement that is adapted to generally reduce the size of the droplets generated when compared with conventional nozzle devices, as well as reduce the droplet size distributions. In addition, it is an object of the present invention to provide a nozzle arrangement that is adapted to enable small droplets of fluid to be generated at low pressures, i.e. when fluids containing reduced or depleted levels of propellant, or a relatively low-pressure propellant such as compressed gas, is used, or a low-pressure system is used, such as a pump- or trigger-actuated nozzle arrangement.

The problem of providing a high quality spray at low pressures is further exacerbated if the fluid concerned has a high viscosity because it becomes harder to atomise the fluid into sufficiently small droplets.

Accordingly, it is a further object of the present invention to provide a nozzle arrangement that is capable of generating a spray from a viscous fluid at low pressures.

A further problem associated with known nozzle arrangements is that certain products have a tendency to block or clog the spray orifices provided in the nozzle arrangement. International Patent Publication Numbers WO 01/89958 and W0 97/31841 both describe cleanable nozzle arrangements, which can be slit apart to expose the internal fluid flow passageway for

cleaning. However, it is not practicable to clean the spray orifices after each individual use, which may be necessary with some products that are particularly prone to clogging the nozzle arrangement. As a consequence, the spray orifices present at the outlet of the nozzle arrangement or within the nozzle can become blocked or clogged with such products, which can adversely affect the performance of the nozzle arrangements and thus, the quality of the spray produced.

Hence, it is a further object of the present invention to provide a nozzle arrangement in which the occurrence of blockages at spray orifices is obviated or at least substantially minimised.

In the case of nozzles fitted to pressurised aerosol canisters, there is also a tendency for the fluid flow through the nozzle to reduce as the contents present in the canister become depleted. As previously indicated, this is primarily due to the depletion of the propellant present in the canister and can be particularly undesirable because it results in the quality of the spray produced by the nozzle arrangement being compromised as the canister approaches the end of its operational lifetime.

For this reason, it is a further object of the present invention to means by which the level of fluid flow through a nozzle arrangement can be maintained at a constant or substantially constant level.

According to a first aspect of the present invention there is provided a nozzle arrangement adapted to be fitted to an outlet of a fluid supply and generate a spray of fluid dispensed from said fluid supply during use, said nozzle arrangement having a body which comprises:

(i) actuator means which is adapted, upon operation, to cause fluid to flow from said fluid supply and through said nozzle arrangement;

(ii) an inlet through which fluid from said fluid supply accesses the nozzle arrangement during use;

(iii) an outlet through which fluid is ejected from the nozzle arrangement during use; and

(iv) an internal fluid flow passageway which connects said inlet to said outlet;

said fluid flow passageway comprising an elongate portion having an inlet end and an outlet end; whereby fluid flowing through the nozzle arrangement during use accesses the elongate portion at the inlet end and flows toward the outlet end, and wherein said passageway is arranged so that said fluid flows into the inlet end of said elongate portion tangentially.

By "tangentially", we mean that the fluid flows into the inlet end of the elongate portion along a tangent with respect to its cross-sectional profile, i.e. it profile at an angle which is perpendicular or substantially perpendicular to the longitudinal axis of the elongate portion of the passageway. In most cases, it is preferred that the fluid flow passageway is circular or substantially circular in cross-section so that the introduction of fluid tangentially means that the fluid stream enters the inlet end and is directed towards the circular or substantially circular internal wall, thereby causing the fluid to swirl within the elongate portion as it continues to flow towards the outlet of the nozzle arrangement. Imparting rotational flow to the fluid stream in this manner has been found to enhance the break up or "atomisation" of fluid droplets flowing through the passageway and, ultimately, ejected through the outlet. Hence, nozzle arrangements configured in this manner can improve the quality of the spray generated (i.e. provide small droplets at reduced pressures with narrow droplet size distributions).

According to a second aspect of the present invention there is provided a nozzle arrangement adapted to be fitted to an outlet of a fluid supply and generate a spray of fluid dispensed from said fluid supply during use, said nozzle arrangement having a body which comprises:

(i) actuator means which is adapted, upon operation, to cause fluid to flow from said fluid supply and through said nozzle arrangement;

(ii) an inlet through which fluid from said fluid supply accesses the nozzle arrangement during use;

(iii) an outlet through which fluid is ejected from the nozzle arrangement during use; and

(iv) an internal fluid flow passageway which connects said inlet to said outlet;

wherein said body further defines an internal chamber disposed at a position along the length of the fluid flow passageway, said chamber having a constricted inlet, though which fluid flowing through the passageway during use accesses the chamber, and a constricted outlet, through which fluid exits the chamber during use.

By "constricted" we mean that the opening defined by the inlet and outlet respectively is narrower than the bore of the internal fluid flow passageway, through which the fluid flows into and out of the chamber.

The provision of an internal chamber having a constricted inlet and outlet has surprisingly been found to contribute to the atomisation of droplets of viscous solutions.

Preferably, the passageway further comprises a swirl chamber positioned downstream of the internal chamber. In an especially preferred embodiment,

the passageway comprises an expansion chamber downstream from the internal chamber, which is in turn followed by a swirl chamber positioned downstream of the expansion chamber.

It is also preferable that an expansion chamber is positioned upstream from the internal chamber. It is especially preferred that such an expansion chamber is fed by a tangential fluid stream input, as discussed above in reference to the first aspect of the present invention.

For the avoidance of doubt, an expansion chamber is an internal chamber, usually (but not necessarily) circular in cross-section, into which fluid passing though the passageway is sprayed through an inlet orifice, but, unlike the internal chamber defined above, it does not possess a constricted outlet. In addition, a swirl chamber is an internal chamber that is configured to impart a rotational and/or swirling motion to the fluid stream passing through the chamber during use. Expansion chambers and swirl chambers are further defined in WO 01/89958, the entire contents of which are incorporated herein by reference.

Preferably, the walls defining the internal passageway taper towards the constricted inlet of the chamber and taper outwards from the constricted outlet orifice. Hence, in preferred embodiments where the internal passageway is of circular cross-section, the portions of the passageway up stream of the chamber inlet, and downstream from the chamber outlet, effectively define portions of the bore of the passageway which are in the form of a truncated cone, as described further in reference to Figure 1A below.

According to a third aspect of the present invention there is provided a nozzle arrangement adapted to be fitted to an outlet of a fluid supply and generate a spray of fluid dispensed from said fluid supply during use, said nozzle arrangement having a body which comprises:

(i) actuator means which is adapted, upon operation, to cause fluid to flow from said fluid supply and through said nozzle arrangement;

(ii) an inlet through which fluid from said fluid supply accesses the nozzle arrangement during use;

(iii) one or more outlet orifices through which fluid is ejected from the nozzle arrangement during use; and

(iv) an internal fluid flow passageway which connects said inlet to said one or more outlet orifices;

wherein said fluid flow passageway further comprises an internal expansion chamber, said chamber having one or more inlet orifices arranged such that the fluid accessing the chamber is directed towards an internal wall of the chamber, and an outlet orifice through which fluid may exit the chamber.

It is especially important that the fluid entering the expansion chamber is directed to an internal wall of the chamber, rather than towards an outlet orifice of the chamber. This ensures that the fluid droplets are exposed to as much disruption as possible within the chamber to atomise the droplets as far as possible.

Preferably, the internal chamber has one or more inlet orifices and one or more outlet orifices, said inlet orifices being arranged in a divergent relationship to one another so that the fluid passing through the internal passageway accesses the chamber through said two or more inlet orifices along two or more independent and divergent paths.

Preferably, the divergent inlet orifices direct fluid towards the internal walls and/or corners of the chamber (rather than the opening of the outlet orifice(s)). It is also preferable that the fluid entering the chamber is directed towards an opposing wall expansion chamber or the corner between an

opposing wall and an adjacent wall of the expansion chamber, rather than the same wall that comprises the inlet orifice(s), or a wall that is directly adjacent to such a wall. Alternatively, one or more posts or protrusions may be positioned within the chamber to provide internal wall surfaces which the fluid may be directed towards.

It is especially preferred that the fluid is directed towards one or more nodules formed on the internal walls and/or corners of the expansion chamber, said nodules being configured to cause further agitation/disturbance to the fluid stream within the chamber (and hence, further atomise the fluid droplets present in the fluid stream).

Preferably, the fluid is sprayed into the internal chamber through the inlet orifices.

In some embodiments the one or more outlet orifices direct fluid present in the chamber into a continuation of the internal fluid flow passageway. It is preferable, however, that the chamber is disposed proximate to the outlet and the one or more outlet orifices of the expansion chamber are also the one or more outlet orifices of the nozzle arrangement.

Alternatively, the internal chamber may be provided with two or more inlet orifices disposed in a convergent relationship with respect to one another so that the fluid streams flowing through the inlet orifices into the chamber are directed towards one another and mix within the chamber. This mixing of fluid streams further contributes to the atomisation of the fluid flowing through the nozzle arrangement during use.

According to a fourth aspect of the present invention, there is provided a nozzle arrangement adapted to be fitted to an outlet of a fluid supply and generate a spray of fluid dispensed from said fluid supply during use, said nozzle arrangement having a body which comprises:

(i) actuator means which is adapted, upon operation, to cause fluid to flow from said fluid supply into said nozzle arrangement;

(ii) an inlet through which fluid from said fluid supply accesses the nozzle arrangement during use;

(iii) one or more outlet orifices through which fluid is ejected from the nozzle arrangement during use; and

(iv) an internal fluid flow passageway which connects said inlet to said one or more outlet orifices;

wherein said internal fluid flow passageway comprises a first orifice-defining portion and a flap having a second orifice-defining portion, said flap being configured to be displaced by the flow of fluid through the internal passageway during use from a first position, in which said flap resides when the nozzle arrangement is not in use and wherein the first and second orifice-defining portions are disposed apart from one another, to a second position, in which said first and second orifice-defining portions are disposed proximate to one another and together define an orifice though which the fluid passing through the nozzle arrangement must pass.

The parts of a nozzle arrangement most likely to become clogged with matter during use are the narrow/constricted portions, such as internal or external orifices. For this reason, the provision of an orifice defined by two (or more) orifice-defining portions, at least one of which is provided on a moveable flap so that it is in its orifice-defining position when the nozzle arrangement is in use (i.e. when fluid is flowing through the nozzle arrangement), but can move away when the nozzle arrangement is not in use to provide a means by which any matter that has become lodged at the orifice can be dislodged. In effect, the orifices are self-cleaning and the build up of residue at the orifices of a nozzle arrangement is dramatically reduced.

Preferably, the first orifice-defining portion is a portion of the body of the nozzle arrangement which defines the internal fluid flow passageway. Preferably, the first orifice-defining portion is in the form of a recess or internal wall, which is adapted to receive the second orifice-defining portion of the flap when it is displaced into the second "orifice-forming" position. The flap may be connected to the side of the fluid flow passageway or, more preferably, it may be positioned within a recess of the chamber wall.

The flap may be connected to the body by a resilient mounting which permits the flap to move from the first position to the second "orifice-defining" position by the pressure of fluid flowing through the internal passageway. Once the fluid flow ceases, the resilient mounting causes the flap to return to the first position, thereby dislodging any residue that may have become lodged in the orifice. More preferably, the flap is itself resiliently deformable and is caused to bend from the first position to the second position by the flow of fluid through the nozzle arrangement, and then return to the first position once the fluid flow ceases.

The second orifice-defining portion of the flap is preferably a freely moveable end of the flap. Alternatively, the second orifice-defining portion may be a semi-circular or otherwise shaped cut-out portion which, together with the first orifice-defining portion forms the orifice when the flap abuts the first orifice-defining portion.

The orifice-defining portions may define more than one orifice. Furthermore, the orifice, once formed, may be positioned upstream from an expansion chamber so as to form an orifice through which fluid can be sprayed into the chamber.

The size of the orifice may vary depending on the pressure with which the fluid is force through. For example, at high pressures the orifice may be

small because the flap is urged into close contact with first orifice-defining portion of the body. At reduced pressures, however, the resilience of the flap may cause it to be further displaced from the first orifice-defining portion of the body.

The orifice(s) defined by the flap may be of any shape, for example circular, square, oblong etc.

According to a fifth aspect of the present invention there is provided a nozzle arrangement adapted to be fitted to an outlet of a fluid supply and generate a spray of fluid dispensed from said fluid supply during use, said nozzle arrangement having a body which comprises:

(i) actuator means which is adapted, upon operation, to cause fluid to flow from said fluid supply and through said nozzle arrangement;

(ii) an inlet through which fluid from said fluid supply accesses the nozzle arrangement during use;

(iii) one or more outlet orifices through which fluid is ejected from the nozzle arrangement during use; and

(iv) an internal fluid flow passageway which connects said inlet to said one or more outlet orifices;

wherein a flow control mechanism is disposed in said passageway, said flow control mechanism comprising a flap which is resiliently deformable so that it can be displaced from a first position in which the passageway is fully open to a second position in which the flap extends into and constricts the passageway in response to the pressure of the fluid flowing through passageway during use, and return to the first position when the actuation ceases and the nozzle arrangement is not in use.

The flap may be configured so that the extent of displacement between said first and second positions is dependent on the pressure with which the fluid flows through the nozzle arrangement. Therefore, the extent to which the passageway is constricted depends principally on the fluid pressure, i.e. as the pressure reduces, the displacement of the flap is less and, as a consequence, the constriction of the passageway is less so that the fluid flow remains substantially the same as when the pressure is higher and the flap constricts the passageway to a greater extent.

Alternatively, the flap may be configured to displace to its fullest extent once a predetermined minimum threshold pressure is exceeded. For example, the flap could be configured so that displaces fully at pressures above 1.5 bars. Therefore, when an aerosol canister equipped with the nozzle arrangement is full and the pressure generated is typically between 4 and 7 bars, the flap will be urged towards the second position by the fluid flow through the passageway and thus, the orifice of the passageway will be constricted by the flap. However, as the pressure in the aerosol canister reduces with use (i.e. as the propellant becomes depleted), the flap will return to the first position when the pressure falls below 1.5 bars. This will cause the passageway to open and thus, increase the fluid flow at lower pressures. This approach is anticipated to enable the fluid flow to be maintained within 25% throughout the lifetime of the aerosol canister.

The flap preferably extends vertically within the passageway, although it may also extend horizontally.

In an alternative embodiment, the flap is displaced into a tapered recess and the gap between the end of the flap received in the recess and the wall of the recess defines the aperture through which fluid may flow. A high pressures urges the flap further into the tapered recess where the gap between the flap and the tapered recess wall is smallest, whereas the size of the gap increases as the

pressure reduces and the resilience of the flap causes it to be urged away from the tapered recess back towards the first position. This results in a larger gap between the recess and the end of the flap being provided at lower pressures and thus, enables the volume of fluid flow through the passageway to be maintained within the desired ranges and also be virtually independent from pressure changes that may occur.

The following general remarks are applicable to all of the aforementioned aspect of the present invention.

The fluid supply may be any suitable fluid supply to which a nozzle arrangement is usually attached. In most cases the fluid supply will be container, such as pressurised hand-held aerosol canister.

The nozzle arrangements of the present invention are preferably formed from plastic.

It is also preferable that the body of the nozzle arrangements of the present invention is composed of at least two interconnected parts. Each part preferably has an abutment surface, which may be brought into contact with one another to form the final nozzle arrangement assembly. One or more of the abutment surfaces preferably comprise grooves and recesses formed thereon which, when the surfaces are brought into contact, define the fluid flow passageway (including any chambers positioned along its length), as well as the outlet and, optionally, the inlet. Preferably, a seal is provided between the abutment surfaces, which prevents fluid passing through the nozzle arrangement from leaking out between the abutment surfaces during use. This construction is preferred because it can be manufactured very cheaply and with a high degree of precision. In addition, the constituent parts of the body may be permanently fixed together to form the final, assembled nozzle arrangement or, alternatively, the parts may remain separable so that fluid flow passageway may

be opened and exposed for cleaning. Most preferably, the nozzle arrangement is formed of two parts interconnected by a hinge so as to enable the respective parts to be moved towards or away from each other to enable cleaning to be effected.

Nozzle arrangements of this construction are described further in WO 01/89958 and W0 97/31841, the entire contents of which are incorporated herein by reference.

The actuator means may be any suitable actuator means that is capable of initiating the flow of fluid through the nozzle arrangement. Various means are well known in the art. For example, nozzle arrangements fitted to pressurised fluid–filled canisters typically comprise and actuator that can be depressed so as to engage and open the outlet valve of the canister and thereby permit the fluid stored therein to be dispensed through the nozzle arrangement. In addition, pump and trigger nozzle arrangements are widely available as a means for dispensing fluids from non-pressurised containers. In these cases, the operation of the pump or trigger generates the pressure, which causes the fluid from the container to be dispensed through the nozzle arrangement.

How the invention may be put into practice will now be described in more detail in reference to the following Figures, in which:

Figure 1A is a cross-sectional view, in diagrammatic form, taken in a vertical plane through the fluid flow passageway of a nozzle arrangement according to the first and second aspects of the present invention;

Figure 1B is a further cross-sectional view, in diagrammatic form, taken in a vertical plane through the fluid flow passageway of an alternative nozzle arrangement according to the first and second aspects of the present invention;

Figure 2 is a cross-sectional view taken in a horizontal plane through a nozzle arrangement according to the third aspect of the present invention showing a portion of the fluid flow passageway up stream from the outlet;

Figure 3A is a cross-sectional view taken in a vertical plane through the fluid flow passageway of a nozzle arrangement according to the fourth and fifth aspects of the present invention, in diagrammatic form;

Figure 3B is cross-sectional view taken along line X-X of Figure 3A.

In the following description of the figures, like reference numerals are used to denote like or corresponding parts in different figures.

Figure 1 shows the fluid flow passageway 101, the outlet 102 and the inlet 103, defined by the body of a nozzle arrangement according to the first and second aspects of the present invention. For the purpose of illustration, only the fluid flow passageway, inlet and outlet are shown.

The nozzle arrangement incorporating the fluid flow passageway shown in Figure 1 is composed of two separate parts, namely a base part and an upper part. The base part is adapted to be fitted to an outlet of a fluid supply, such as a pressurised aerosol canister, and has an upper abutment surface extending generally along the plane of the line 104 shown in Figure 1A. Fitted to the base is the upper part, which provides a corresponding abutment surface that contacts the abutment surface of the base to form the final, assembled nozzle arrangement. Each of the abutment surfaces have grooves and/or recesses formed thereon which align when the abutment surfaces are contacted together to define an elongate portion of the fluid flow passageway 101a as well as the outlet 102, as shown in Figure 1A. In addition, the base also defines an inlet portion 101b of the passageway 101.

The elongate portion 101a has an inlet end 105 and an outlet end 106. The entire elongate portion is circular in cross-section. During use, fluid is caused to access the nozzle arrangement through the inlet 103, and flow through the inlet portion 101b of the fluid flow passageway into the inlet end 105 of the elongate portion 101a. The fluid then continues through the elongate portion towards the outlet end 106 of the elongate portion where it is ejected from the nozzle arrangement through the outlet 102. It shall of course be appreciated that the fluid is caused to flow by the operation of an actuator (not shown).

Fluid is introduced into the inlet end 105 tangentially. In other words, the fluid stream is directed along a tangent of the cross-section of the inlet end, i.e. along a straight path which dissects the circular cross-section. This causes the fluid to impact on the circular side wall of the inlet end and thus is caused to rotate or swirl by the curvature of the wall. This includes a rotational swirl to the fluid stream as is passes along the elongate portion 101a towards the outlet.

The fluid flow passageway 101 shown in Figure 1A additionally comprises an internal chamber 106 disposed along its length. The chamber has a constricted inlet 107 through which fluid access the chamber 106 from the fluid flow passageway 101, and a constricted outlet 108, through which fluid exits the chamber and is returned to the fluid flow passageway 101 to continue its passage towards the outlet 102. As shown in Figure 1A, the side walls of the fluid flow passageway preferably taper towards the constricted inlet 107 and away from the outlet 108, effectively defining a bore in the form of a truncated cone, as shown by portions 109 and 110 of the fluid flow passageway respectively. The provision of this arrangement greatly entrances the break-up of the fluid droplets, especially with viscous solutions.

Figure 1B shows an alternative embodiment, which is identical to the embodiments shown in Figure 1A, except that the constricted inlet 107 and

constricted outlet 108 to the internal chamber 106 which are elongated relative to the inlet 107 and outlet 108 shown in Figure 1A. The provision of elongate constricted inlets and outlets provides the same effect on the break-up of fluid droplets as the embodiment shown in Figure 1A.

Figure 2 shows a cross-section taken in a horizontal plane through an embodiment according to the third aspect of the present invention. In Figure 2 only the outlet portion of the nozzle arrangement is shown, but it shall be appreciated that the nozzle arrangement additionally comprises an inlet through which fluid accesses the fluid flow passageway 101 and travels towards the outlet 102. The nozzle arrangement is formed from a base part and an upper part, with the fluid flow passageway 101 and the outlet orifices 102 formed between the abutment surfaces of the upper and lower parts, as discussed above in reference to Figure 1A.

During use, the fluid flow passageway 101 feeds fluid into a first chamber 201 through a constricted inlet 202. This causes the fluid to be sprayed into the first expansion chamber. Fluid passing through the first expansion chamber travels along a series of divergent orifices 203, which form divergent inlet orifices to a second expansion chamber 204. The second expansion chamber is provided with three outlet orifices 102, through which fluid is ejected from the second chamber and the nozzle arrangement. An important feature of this embodiment resides in the divergent inlet orifices being arranged so that fluid entering the second chamber is directed against the opposing wall 206, or a corner between an opposing wall 206 and an adjacent wall 207, rather than directly towards the outlet orifices 102. The consequence of this arrangement is that fluid is caused to impact on the opposing wall and/or the corner between an opposing wall and the adjacent wall and thereby causes the disruption of the fluid stream and further atomises the droplets contained therein.

Figure 3A shows an embodiment of a nozzle arrangement according to both the fourth and fifth aspects of the present invention. The nozzle arrangement is formed from a base part 350 and an upper part 351, as previously described in reference to Figure 1A. In this embodiment, however, the fluid flow passageway 101 comprises a chamber 301 which comprises an upstanding flap 302 mounted therein. The flap has an orifice defining end portion which, together with the orifice-defining portion of the body, defines an internal orifice 305. The flap 302 is configured to be resiliently deformed by the flow of fluid through the nozzle arrangement during use from the first position (not shown), whereby the orifice defining portion 303 of the flap is displaced from the orifice defining portion 304 of the body, to a second position, whereby the orifice-defining portions of the flap and body, 303 and 304 respectively, are disposed proximate to one another, as shown in Figure 3A, and together define an internal orifice 305 through which fluid must pass during use.

Figure 3B shows a cross-sectional view taken along line X-X of Figure 3A. In this figure the upper part 351 and the base part 350 can be clearly seen. The upstanding flap 302 has as its orifice-defining portion a cut away portion 313. The lower edge of cut-away portion 313 forms the orifice 305 through which fluid exiting the chamber 301 must pass.

It shall of course be appreciated that once the flow of fluid ceases through the nozzle arrangement, the flap returns to the first position by virtue of its inherent resilience. This causes any residue that may have built up at the internal orifice to become dislodged.

In addition, the embodiment shown in Figure 3A and 3B is also an embodiment which comprises a flow control mechanism according to the fifth aspect of the present invention. Specifically, the flap 302 can be configured so that it only moves from the first position to the second position at a

predetermined pressure. Thus, a constricted internal orifice 305 is formed, which restricts the flow of fluid, at pressures above the predetermined minimum, and, when the pressure falls below the predetermined minimum, the flap returns to the first position in which the portions 303 and 304 are displaced from one another, thereby creating a wider path through which the fluid can flow. This serves to maintain the flow rates within a range of approximately 25%.

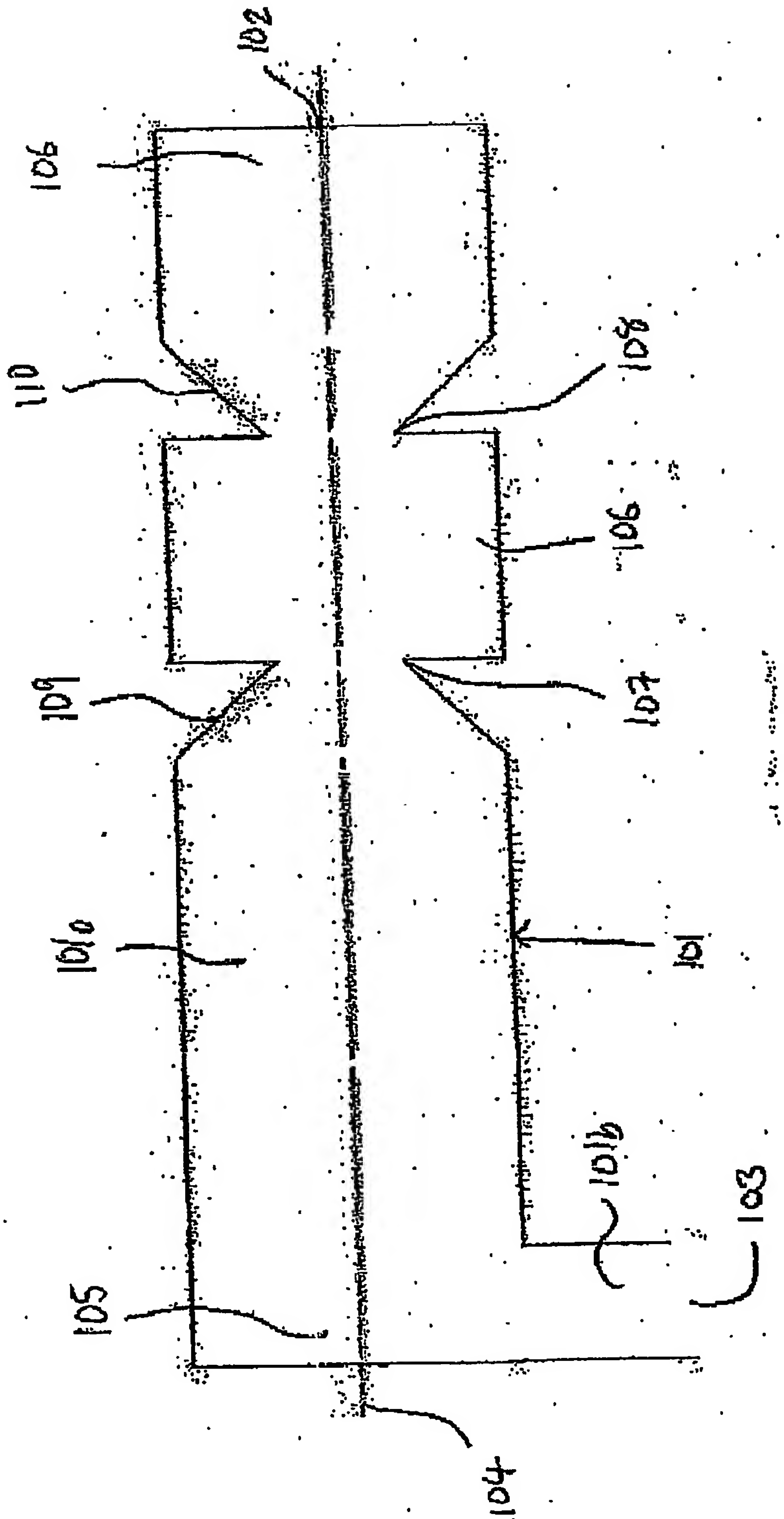

Figure 1A

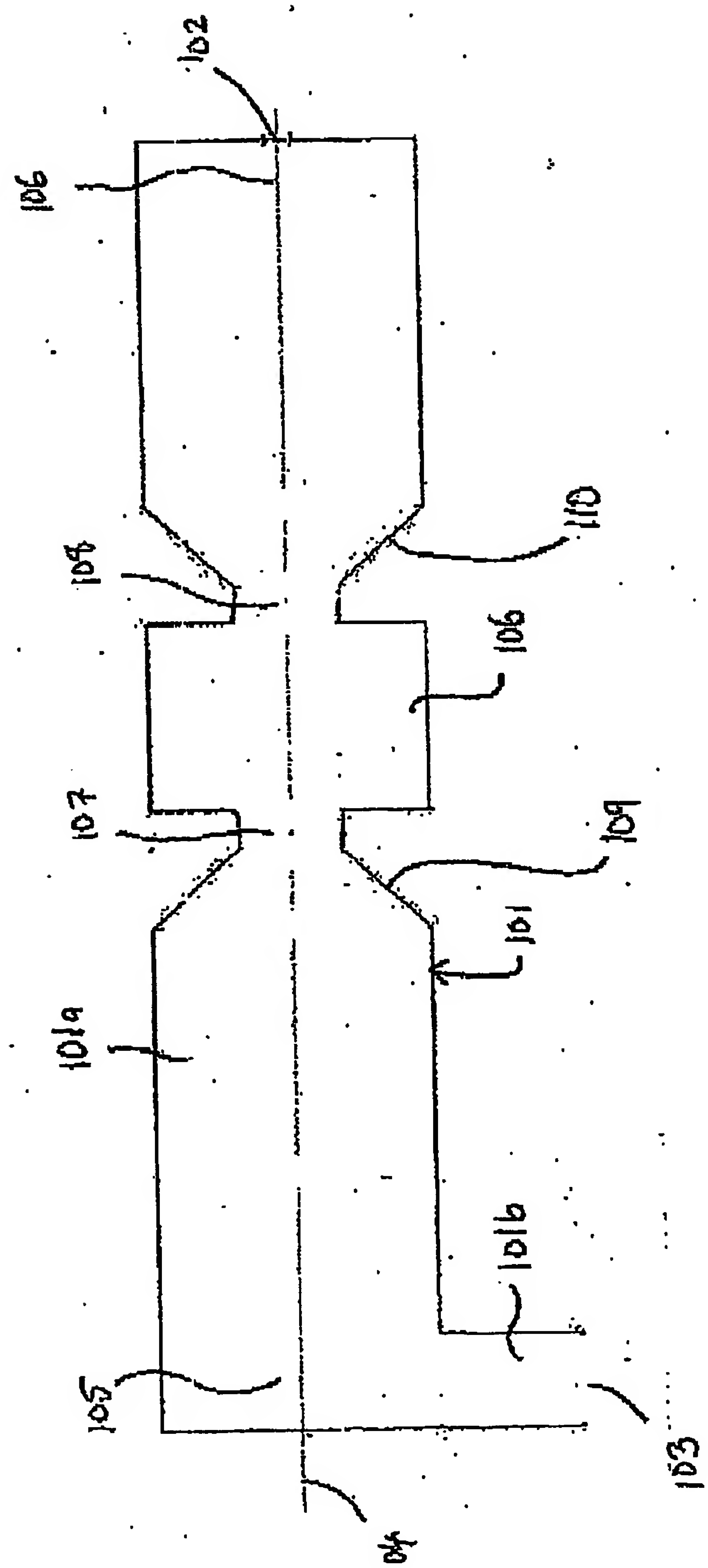

Figure 1B

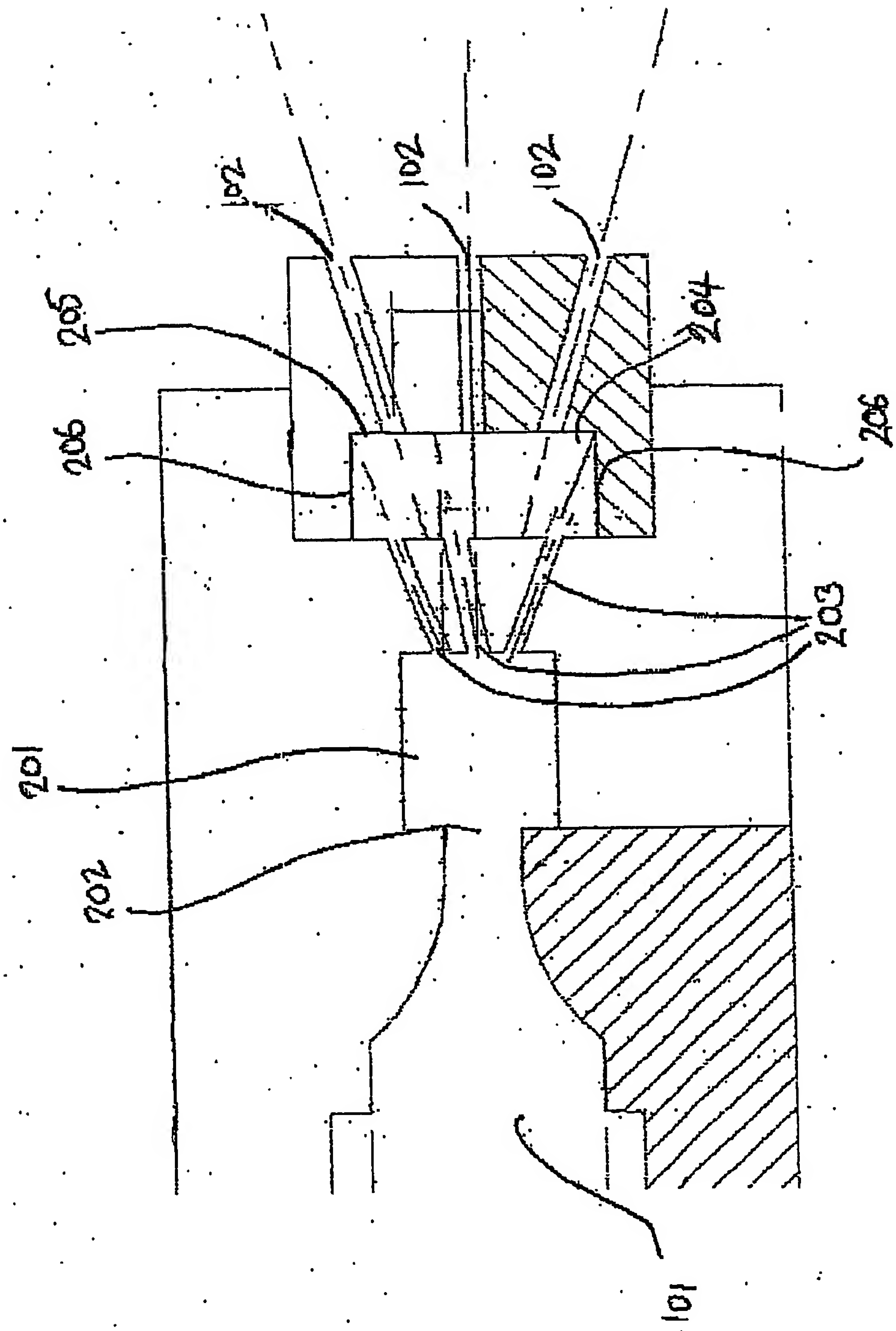

Figure 2

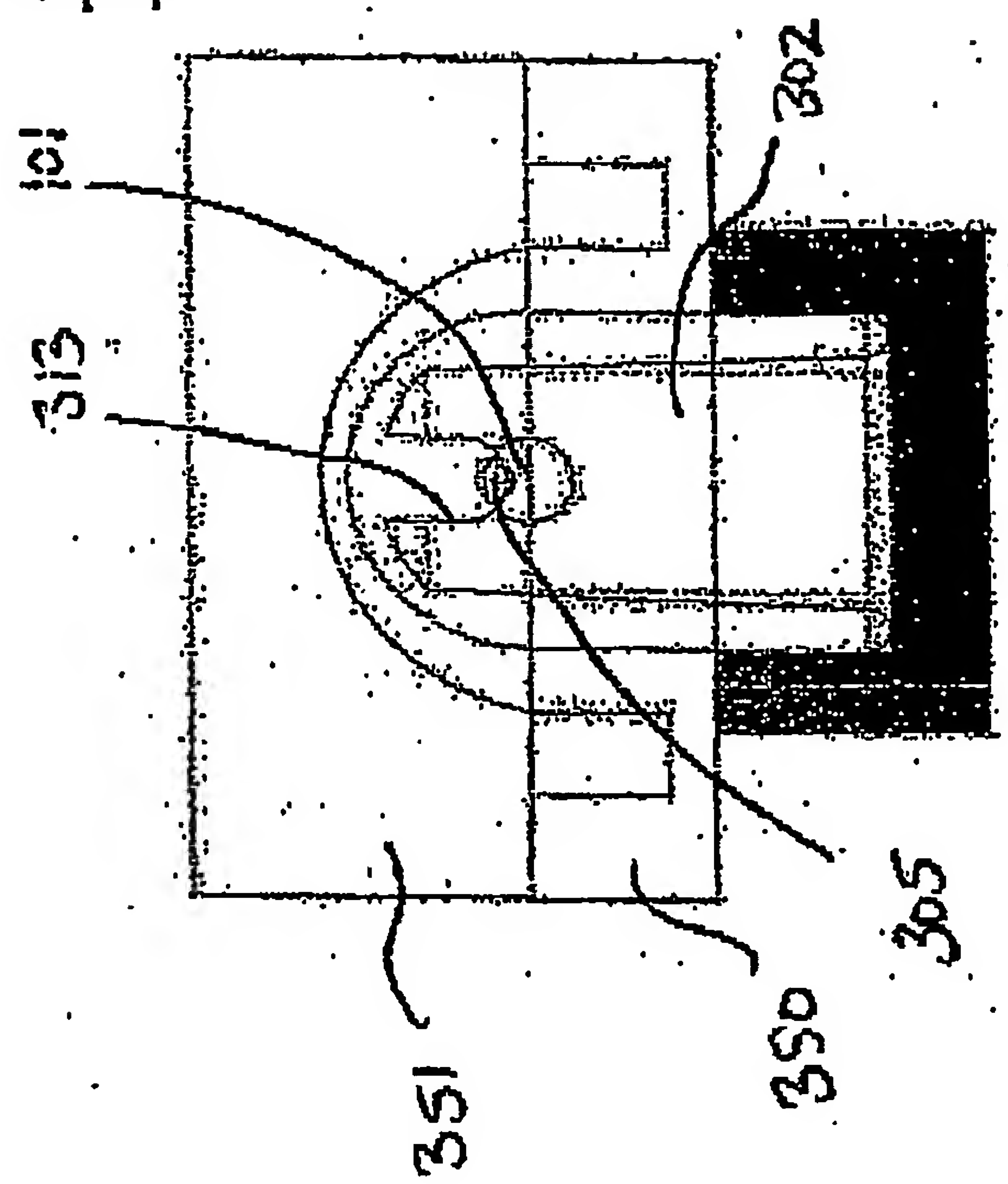

Figure 3B

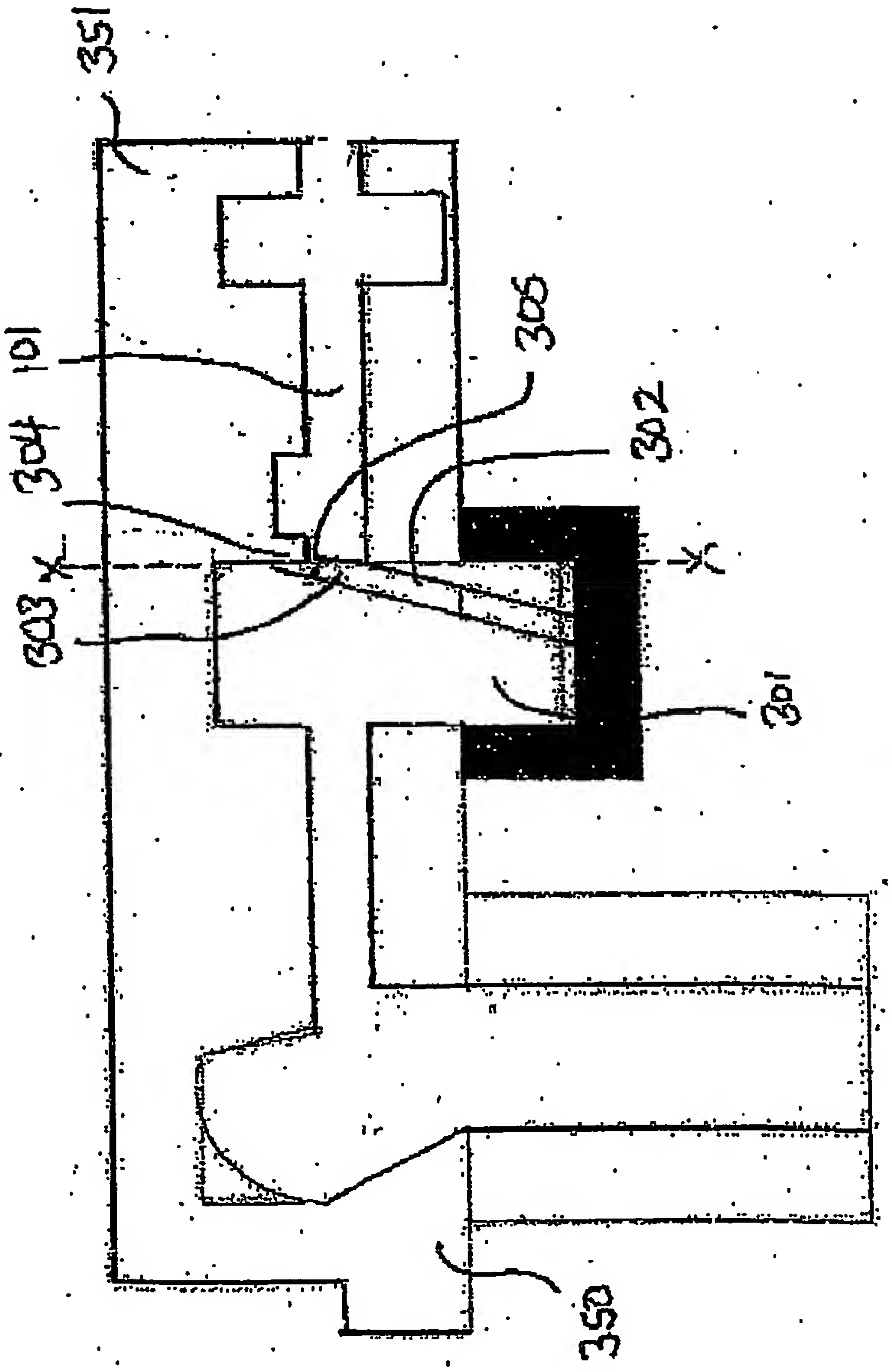

Figure 3A